OBSERVATIONS AND RECORDS OF *MYOTIS (PIZONYX) VIVESI* MENEGAUX (Chiroptera: Vespertilionidae)

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ABSTRACT: A large number of *Myotis* (*Pizonyx*) *vivesi* Menegaux were observed at a minimum distance of four nautical miles from land from the research vessel, *Velero IV*, trawling in 800 fathoms of water in the Canal de Salsipuedes, Gulf of California, at a speed of four knots. Bats accompanied the vessel for a minimum of three hours flying into a headwind of 16 knots. Flight patterns in relation to the vessel and apparent feeding behavior are described. Contents of the intestinal tracts of three specimens included finely masticated muscle tissue, fish scales, at least one piece of a caridean shrimp and a structure thought to be the abdomen of an unidentified polychaete larva. New records for *Myotis vivesi* are Isla de Alcatraz, Sonora, and Bahía Rosario, Baja California Sur, the latter being the southernmost distributional record.

Detection of localized surface disturbances of the water are discussed as a possible means of food detection. The correspondence between the distribution of *M. vivesi* and areas of large scale upwellings and subsequent phytoplankton blooms in the Gulf of California and adjacent Pacific Ocean is noted.

Three roundworms, genus *Trichuris*, the mites *Spinturnix mexicanus* Rudnick and *Steatonyssus leptus* Radovsky and ticks of the genus *Ornithodoros* were found as parasites on *M. vivesi*. All known ectoparasite records from *M. vivesi* are presented.

Similarity in morphological and behavioral characteristics (including piscivorous habits) between *M.* (*Pizonyx*) *vivesi* and other species of *Myotis* is noted. The taxonomy of *Pizonyx* Miller is discussed, and the taxon is considered a subgenus of *Myotis* Kaup.

In the course of a midwater trawl in the Gulf of California on the evening of November 30, 1967 the research vessel, *Velero IV*, was nearly engulfed by a large aggregation of bats. The circumstances and observations of this incident merit reporting.

Observations and distributional records: At 11:30 PM three non-gravid, non-lactating females were caught in large dip nets as they flew past the fantail and were subsequently prepared and identified as *Myotis* (*Pizonyx*) *vivesi* Menegaux (LACM 28273-28275).

When the bats were caught, the vessel was trawling in a northwesterly direction in 800 fathoms of water in the Canal de Salsipuedes (sometimes written Sal si Puedes) at a speed of four knots. The exact location was 4.2 nautical mi. W (263° Radar Target) of Isla Salsipuedes, 28° 43′ 58″ N, 113° 04′ 00″ W. Barometric pressure was 29.97 in. Hg, sea temperature was 21.1° C (70° F), and the wet and dry bulb air temperatures were 16.1° C (61° F) and 19.7° C (67.5° F), respectively.

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At approximately 11 PM a single bat was noticed when it flew up the port passageway outside the gallery. This was the first time that any of the scientists were cognizant of the situation. Personnel on the bridge, however, reported that the bats first appeared at 10 PM and were continuously present until about 2 AM of December 1 when they all left abruptly. A minimum of 17 nautical miles was traversed during this four hour time interval. At 10 PM the vessel was a minimum of four nautical miles from the closest land mass, Isla las Ánimas, while at 2 AM Isla Partida was 4.7 nautical miles to the east, and Punta de las Ánimas (mainland Baja California Norte) was 2.5 nautical miles to the west. The vessel was never closer than four nautical miles to any land during the first three hours.

Due to its specialized habitat, it is unlikely that *M. vivesi* is ubiquitously distributed throughout the islands of the Gulf of California and adjacent land areas. Maya (1968) found *Pizonyx* present in January, spring and summer on the following four islands in the vicinity of the Canal de Salsipuedes: Partida (= Isla Cordonosa, the type locality), Raza, Salsipuedes and San Lorenzo. For a summary of distributional records see Maya (1968), Reeder and Norris (1954), and Banks (1964). In addition to the Canal de Salsipuedes record, there are specimens in the Los Angeles County Museum of Natural History (LACM) mammal collection from two unpublished localities as follows: Isla de Alcatraz, Bahía Kino, Sonora, Mexico (33 specimens, LACM 13109-13140, collected by A. L. Gardner, June 25 through July 9, 1960) and Bahia Rosario, Baja California Sur, Mexico (9 specimens, LACM 28276-28286, collected by K. E. Stager, March 23, 1963). The latter specimens were taken from under rocks on a small island at the south end of Bahia Rosario (24° 15′ N, 110° 09′ W), *ca.* 7 mi. SE Punta Coyote, and constitute the southernmost record for this species.

Reeder and Norris (1954) reported a probable sight record of this species at sea two miles off Punta Malarrimo, Bahía de Sebastian Vizcaino, Pacific side of Baja California. Our specimens from Salsipuedes appear to be the first conclusive evidence of *M. vivesi* occurring at considerable distances from land.

According to the ship's log the wind was from the southeast at 6 knots at 9 PM, "calm" at 10 PM, and thereafter from the northwest at an average velocity of 16 knots. Several observers noted that the bats first appeared during the period of calm and for the remaining four hours flew alongside the vessel into a 16 knot headwind.

Despite the absence of moonlight, observation was made possible by the vessel's running lights, a portable spotlight, and special lights on the fantail and A-frame which supported the trawl. Extent of visibility is estimated to have been 13.7 m (45 ft.) from the vessel. No phosphorescence or bioluminescence was observed in the water.

Approximately two hundred individuals were estimated to be visible around the fantail at any one moment. The total number is conservatively estimated to have been at least twice that number. It is not known if the same individual bats were present during the entire four hours or even if those visible at any one moment were just part of a much larger, and unobservable number.

Bats were observed flying all around the vessel except directly in front of and under the bow, but they appeared to be concentrated around the stern, presumably because of the lights and wake of the vessel. Most individuals remained more than 2.4 m (8 ft.) from the vessel, but some bats flew diagonally across the stern of the vessel and maneuvered to avoid the superstructure of the vessel and the attempts of observers to catch them in dip nets. Those alongside the vessel appeared to fly repeatedly in an oval pattern, the long axis parallel to the ship. From the vicinity of the bow individuals would fly adjacent to the sides of the ship until reaching the stern where they would disperse over the wake of the ship, reorient into the wind, drop down to the water surface, and fly forward toward the bow. In the forward flight bats were observed just above the sea surface until reaching the vicinity of the bow where they abruptly rose in altitude. Flight speed in the sweep toward the stern was discernibly faster than that toward the bow. The bats appeared to be definitely interested in the area of crests produced by the wake of the vessel as well as the choppy sea surfaces lateral to the vessel.

Bats at the stern were estimated to be flying 2 in. to 1 ft. above the surface and were definitely observed to dip downward touching the water. Several observers reported that they actually saw the bats touching the water surface but could not distinguish which body part made contact. Robert J. Lavenberg states, that while operating the spotlight, he observed individual bats swoop down until just above the water surface and then alternately lower and raise their feet, making contact with the water.

Lavenberg's observation is pertinent in light of the controversy over the manner in which food is procured. Miller and Allen (1928) and Burt (1932) reasoned that the elongated, laterally compressed and recurved feet functioned to capture small fish or crustacea. On the basis of several observations, Reeder and Norris (1954) stressed that the tail, uropatagium and calcar cartilages appeared to be the primary mechanism. Walker (1950) observed a V-shaped ripple mark remaining after a low swoop by a bat and believed that this was made by the animal's chin. To our knowledge no one has recorded observing *M. vivesi* actually obtaining prey from the sea, although Maya

(1968, p. 65) observed several individuals ". . . with fish in their claws." In addition to the feet, the tail and uropatagium were considered by Maya (1968) to be used in capturing prey because these were often wet and frequently bore fish scales.

Food: After examination of both guano and stomach contents, Burt (1932, p. 364) found definite evidence of ". . . fish remains, chiefly scales with an occasional small fish bone." Burt further reported (p. 363) that one of the bat stomachs was found to contain fish ". . . belonging to the sardine tribe." On the basis of circumstantial evidence, Walker (1950) believed the diet to consist of small shrimp. He further theorized that upon approaching the water surface the white venter (atypical for the genus *Myotis*) served to agitate and frighten schools of crustaceans, thus facilitating their capture. Reeder and Norris (1954) recorded in stomach contents small crustaceans and, in one specimen, many insect fragments. Norris (Reeder and Norris 1954, p. 85) observed one bat in flight ". . . holding a shining little fish in its hind feet." Of an undisclosed number of fecal pellets obtained from roosting sites, Carpenter (1968, p. 956) found ". . . 62.5 per cent contained remains of only crustacea, 26.3 per cent contained only fish remains and 11 per cent contained remains of both." Maya (1968) found the presence of crustaceans, fish, insects, and algae in the stomachs of 22 specimens. In droppings he found some indication of seasonal variations in the relative frequences of the above food items, but concluded that crustaceans were the major food source. Examination of the digestive tracts of our three specimens disclosed finely masticated pieces of muscle tissue, fish scales, at least one piece of a shrimp (Decapoda: Caridea) and a structure thought to be the abdomen of an unidentified polychaete larva. Analysis of the fish scales revealed that the majority were from the family Myctophidae (lantern fishes), comparing well in size, shape and other scale characters to those of the genera *Hygophum, Diaphus* and *Triphoturus*. Thirteen of the 65 scales showed a definite, raised center portion which appeared to be the lens remnant of a myctophid photophore scale whereas 50 additional scales were non-photophore myctophid scales. Two scales were small and ctenoid and were not myctophid in origin, those of the latter being larger and cycloid. Many myctophids are vertical migrators from great depths at night when they would occur at the surface.

From roosts of *M. vivesi* Maya (1968) found the dry and partially chewed remains of the following fishes: *Lile stolifera, Ophisthonema liboleta* [sic, *Opisthonema libertate*], bothids, and perhaps flying fish, with bothid remains being the most common. Adult flatfishes of the family Bothidae are benthic whereas the larvae and prejuveniles live in plankton. Scale development is probably slight, if at all, during the planktonic stages. The degree of scale development of the bothid remains mentioned by Maya (1968, fig. 15) would indicate that they were probably recently developed juveniles which inhabit shallow waters near shore. *Lile stolifera* and *Opisthonema libertate* are herrings (Clupeidae) and are surface schooling fishes.

When removed from the dip net, one of the three bats was discovered to have a small unidentified shrimp adhering to the surface of the uropatagium. During the frantic efforts to capture the bats as they flew close to the sides of the vessel and across the fantail, one of the specimens was caught in a dip net which subsequently touched the water before being raised to the deck. It is not known whether or not the specimen bearing the crustacean was the one involved nor is it known if the shrimp was present when the bat was initially caught or if it was originally adhering to the dip net and subsequently transferred to the bat.

Food detection: The bats emitted audible sounds described as short, high pitched squeals, which were readily discernible. The overall intensity of sound varied in direct proportion to the height of flight, being loudest when the bats were closest to the water. No noticeable change in pitch was reported by the observers whereas Maya (1968, p. 66) states that "As they approach the surface, their vocal chatter, a series of short bursts, becomes high pitched, more rapid, and finally inaudible."

Suthers (1965) found that in captivity *Noctilio leporinus* Linnaeus, a neotropical bat known to be piscivorous, could readily detect small wires projecting vertically above the water as well as localized minor disturbances in the water surface. *M. vivesi* probably detects prey in the same manner as *N. leporinus* although in a subsequent study Suthers (1967) reported a difference in the orientation sounds produced by these two species. He was unable to induce captive *M. vivesi* to take pieces of shrimp from the surface of an experimental pool.

The behavior and apparent feeding forays by *M. vivesi* in the areas adjacent to the stern and sides of the vessel may have resulted from disturbances of the water by the wind and the passage of the vessel. The choppy sea produced by the wind was similar to the wake of the vessel. Once agitated, any small fish or crustacean could well have produced small surface disturbances, thus facilitating their capture by the bats.

Maya (1968, p. 67) mentions that *M. vivesi* cannot select only small fish, pointing out that ". . . many [of the fish] caught are frequently too large for effective feeding." On another occasion he witnessed a bat ". . . hovering above and actively pursuing an object" (1968, p. 66). Maya recovered the object which was an unidentified shrimp (1968, pp. 61 and 66, fig. 16). Judging from the scale in the figure the shrimp appears about 6 cm. long and too large for effective feeding by *M. vivesi*. This would seem to be a logical consequence if *M. vivesi* was reacting to a localized surface disturbance rather than discriminating as to the kind and size of organism producing the disturbance.

The known distribution of *M. vivesi* conforms in general with areas of the Gulf of California and adjacent areas of the Pacific Ocean subject to large scale upwellings and subsequent phytoplankton blooms, *e.g.* the Canal de Salsipuedes (Parker, 1964, p. 35). Perhaps *M. vivesi* actively seeks out those areas where their prey species, higher trophic level consumers, would be relatively more abundant.

Parasites: Three female roundworms of the genus *Trichuris* (Dorylaimida: Trichinellidae) were found as intestinal parasites in one of our three specimens. In addition, three types of ectoparasites were found: one mite, *Spinturnix mexicanus* Rudnick (Acarina: Spinturnicidae); two protonymphs of the mite, *Steatonyssus leptus* Radovsky (Acarina: Macronyssidae); and four specimens of a tick of the genus *Ornithodoros* (Acarina: Argasidae), which apparently are not *O. dyeri* Cooley and Kohls (Glen M. Kohls, personal communication).

The following ectoparasites have been recorded from *M.* (*Pizonyx*) *vivesi*: *Ornithodoros dyeri* Cooley and Kohls (1940) (Acarina: Argasidae); *Whartonia sonorensis* Hoffmann (1960) (Acarina: Trombiculidae); *Trombicula thompsoni* Brennan (1966) (Acarina: Trombiculidae); *Speleocola cortezi* Loomis and Webb (1969) (Acarina: Trombiculidae); and the batfly, *Basilia pizonychus* Scott (1939) (Diptera: Nycteribiidae). The latter has also been reported by Reeder and Norris (1954) and Maya (1968). Rupert L. Wenzel (personal communication) reports that there are no Streblidae known from *M. vivesi. Whartonia sonorensis, Speleocola cortezi* and *Basilia pizonychus* are known only from *M. vivesi.* Apart from the one record on *M. vivesi, Trombicula thompsoni* is known only from marine birds in the Caribbean. At one time, *Ornithodoros dyeri* was known only from guano and rock crevices of bat caves, mines, and tunnels from several localities in the western United States and Mexico, but it is now known from both *M. vivesi* and the sac-winged bat, *Balantiopteryx plicata* (Kohls, Sonenshine, and Clifford, 1965). Because it is incomplete, current parasitological information can furnish little evidence concerning the taxonomic relationships between *M. vivesi* and the other species of *Myotis.*

Taxonomy: We have followed the suggestions of Ellerman and Morrison-Scott (1951, p. 138) and subsequent investigators that *Pizonyx* Miller and *Myotis* Kaup be regarded as congeneric. These two have been shown to be essentially similar in hair structure (Benedict, 1957), baculum (Hamilton, 1949), and karyotype (Baker and Patton, 1967). Characteristics used to distinguish *Pizonyx* from *Myotis* have been summarized by Baker and Patton (1967) and are primarily associated with a piscivorous habit (Miller, 1906 and 1907).

To support the generic retention of *Pizonyx*, Maya (1968) stressed piscivorous behavioral adaptations and specializations in water metabolism. However, other species of *Myotis* are now known, or strongly suspected, to be piscivorous and exhibit many of the same specialized morphological and behavioral characteristics formerly regarded as unique to *Pizonyx.* These species are as follows: *M.* (*Leuconoe*) *megalopus* (Dobson), Africa, (Aellen and Brosset, 1968); *M.* (*Rickettia*) *ricketti* Thomas in Asia [discussed as *Vespertilio pilosus* Peters by Allen, 1936]; *M.* (*Leuconoe*) *macrotarsus* Waterhouse, Asia, and *M.* (*Leuconoe*) *daubentoni* Kuhl, Europe (Brosset and Deboutteville, 1966).

The subgeneric designations follow Tate (1941) and are distinguished by enlarged feet, *Leuconoe*, versus enormous feet, *Rickettia*, in addition to other characteristics similar to those of *Pizonyx*. The big-footed condition according to Tate (1941), at least in *Leuconoe*, is due to phalangeal elongation (as in *Pizonyx*) and not to metatarsal elongation as stated by Maya (1968). In addition to the aforesaid species, *Myotis dasycneme* Boie (Europe and Asia), *Myotis macrodactylus* Temminck (Japan), and *Myotis stalkeri* Thomas (Kei Islands) also have large feet.

Although a white venter is not common in the genus *Myotis*, it cannot be considered unique to *Pizonyx*. Specimens in the American Museum of Natural History of *M. ricketti, M. daubentoni* and *M. dasycneme* all possess a conspicuous and extensive white frosting to the venter.

Braun (1965) and Carpenter (1968) have shown that kidney structure and water metabolism, respectively, of *M. vivesi* are highly specialized, but without equivalent information for the other species of *Myotis*, it is difficult to interpret the taxonomic significance, if any, of this information. Surely the desert species of *Myotis*, if not the others, are also specialized in renal physiology, morphology and water metabolism. Dalquest (1948) reports that both *Myotis californicus* (Audubon and Backman) and *Myotis yumanensis* (H. Allen) apparently drink saltwater.

Whether or not the characteristics common to both *M. vivesi* and the several old world species indicate convergence or a common phylogenetic origin is a question yet to be resolved. Certainly the present taxonomic arrangement appears illogical and inconsistent, and pending a revision of all the taxa concerned, we have considered *Pizonyx* a subgenus of *Myotis*.

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